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FOREST PRODUCTS LABORATORY † FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

SPECIAL METHODS OF SEASONING WOOD

VACUUM DRYING OF WOOD

U.S. DEPOSITORY

Many different processes have been proposed for using a vacuum to dry wood. Charles Howard was granted a patent for a vacuum process in 1893 and numerous variations have been patented since. No vacuum process for drying lumber has come into general use either here or abroad, except the steaming and vacuum process used to condition poles and other forms of pine timber prior to preservative treatment. Although amazing results have been obtained by drying lumber in small experimental vacuum-drying equipment, there are several limitations to the use of the process in large-size commercial equipment. Because of these limitations, the Forest Products Laboratory has never thoroughly investigated this process.

A vacuum is merely a reduced air pressure, and the principles of drying are no different at a very low pressure than at any other pressure. The use of a vacuum alone is not effective for rapidly drying wood. Drying of wood involves two processes, movement of water to the surface of the wood and removal of that water from the surface. A vacuum maintained by continuously withdrawing the vapors from a drying chamber materially aids removal of the water from the surface for a short time, but considerable quantities of heat are required to evaporate water. The evaporation of water from wood in a vacuum quickly cools the wood so that evaporation becomes very slow in spite of the vacuum. Furthermore, except at the very start, the rate of drying of wood is governed by the rate of moisture movement from the interior to the surface. A vacuum has very little effect on the rate of moisture diffusion through wood. The vacuum processes proposed for drying wood, therefore, have incorporated some means of heating the wood before the vacuum is applied. Hot air, hot water or other liquids, and steam have been used for heating.

A large load of lumber cannot be heated uniformly by ordinary means during the vacuum period because there is no air or other substance in the vacuum to carry heat from the heating elements to the lumber by conduction or convection. There is no practical way of heating the lumber in the middle of a large load by contact or radiant heat. Although radiant heat may produce amazing results on a few boards in small apparatus, the only heat available in the center of a large load is heat stored in the wood during the heating period. The maximum amount of heat possible to store in wood by heating with any means is limited, depending on the maximum temperature used, the density of the wood, and the amount of water in the wood. The amount of evaporation that can be accomplished by one heating-and-vacuum period, therefore, also is limited.

When the heating medium is withdrawn and the vacuum applied, some of the liquid water present in the cell cavities can be forced out of pervious wood by mechanical action, because of the differential in pressure between the wood and the vacuum. This difference can be increased by steaming or otherwise heating at pressures above atmospheric. The amount of water removed by this mechanical action is limited and is negligible for refractory woods

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through which water does not diffuse readily, such as sweetgum heartwood. These refractory woods are also very resistant to moisture diffusion eyen at temperatures above the boiling point of water.

Most of the water evaporation also takes place during the first part of the vacuum, resulting in a rapid cooling of the wood. There is no advantage in prolonging the vacuum more than 2 hours, because, at the low temperatures reached, evaporation is very slow.

Because of the limited amount of drying possible with one heating-and-vacuum cycle, a number of cycles of alternating heating and vacuum must be used to dry wood to low moisture content values. When the liquid water originally present in the cavities of the wood cells has been taken out of the wood at approximately 30 percent moisture content, no further drying by mechanical action occurs. The rate of heating of the wood and the diffusion of water through the wood become slower and slower as the moisture content is lowered so that the vacuum process becomes increasingly inefficient. If steam is used as a heating medium, a point of equilibrium is reached where the moisture absorbed by the wood during the heating is equal to the amount removed during the vacuum, and no further drying occurs. It would be ideal to use humidified air as a heating medium, controlling the conditions so that little or no moisture is taken from or given to the wood during the heating, but such conditions are difficult to control in the vacuum process.

In addition to the limitations of the process, the fact that the equipment is expensive works against commercial utilization. Also, the woods which dry rapidly in a vacuum can be dried rapidly in an ordinary kiln.

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